Advanced Hot Reservoir Variable Conductance Heat Pipes for Planetary Landers, Phase I

Completed Technology Project (2018 - 2019)

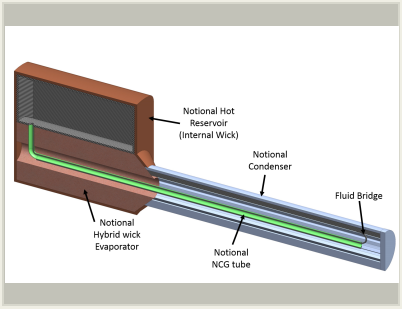
Project Introduction

In contrast to the standard cold reservoir Variable Conductance Heat Pipe (VCHP) where for tight thermal control an electrical heater is used for the reservoir (wicked), Advanced Cooling Technologies, Inc (ACT) developed a hot reservoir VCHP with the reservoir thermally coupled to the evaporator. This novel feature will provide a tight temperature control capability without the need for control power. Based on the recent ISS testing result, it was concluded that working fluid management within the reservoir and the NCG tube (typically non-wicked) of VCHPs is the key to advance the reliability of a hot reservoir VCHP, which will secure a successful long-term mission of planetary landers. Under this STTR topic, ACT will collaborate with Case Western Reserve University (CWRU) to implement several novel fluid management features to enhance system reliability of hot reservoir VCHP. ACT will develop several advanced fluid management features and test their performance on a hot reservoir VCHP prototype. In parallel, CWRU will perform a fundamental study and mathematical model development to simulate and understand the complexity of the transport phenomena problem within the two-phase working fluid and non-condensable gas mixture in the reservoir and the NCG tube. The objective of the CWRU's effort is to bring deep understanding of the thermal-fluid and thermodynamic environment in the VCHP reservoir and NCG tube and identify an effective purging mechanism (i.e. vapor removal from a hot reservoir), which is crucial in designing a reliable hot reservoir VCHP for future planetary lander thermal management.

Anticipated Benefits

The next generation of polar rovers and equatorial landers is the immediate NASA application. A hot reservoir VCHP with enhanced reliability will be needed, which is able to operate during large tilts, shut down during the long Lunar night and maintain the temperature lander vehicle over a wide sink temperature fluctuation on the Lunar surface.

Astrobotics Technology, as one of the primary developers of space robotics for planetary missions has expressed a great interest on ACT's hot reservoir VCHP technology and anticipate to apply the advanced version to their lander vehicles for Lunar and Mars surface operation.



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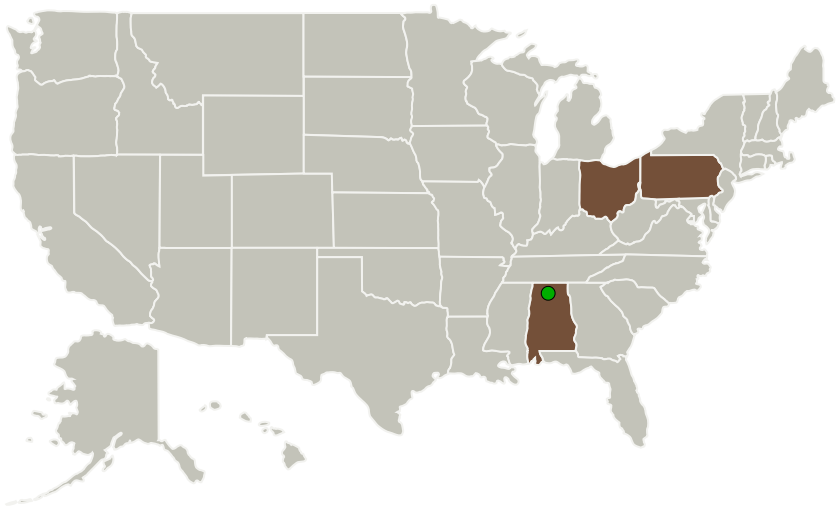
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Advanced Cooling Technologies, Inc.	Lead Organization	Industry	Lancaster, Pennsylvania
Case Western Reserve University	Supporting Organization	Academia	Cleveland, Ohio
Marshall Space Flight Center(MSFC)	Supporting Organization	NASA Center	Huntsville, Alabama

Primary U.S. Work Locations	
Alabama	Ohio
Pennsylvania	

Project Transitions

July 2018: Project Start

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Advanced Cooling Technologies, Inc.

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

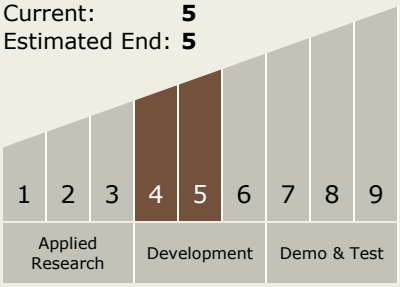
Carlos Torrez

Principal Investigator:

Kuan-lin Lee

Technology Maturity (TRL)

Start: **4**
Current: **5**
Estimated End: **5**



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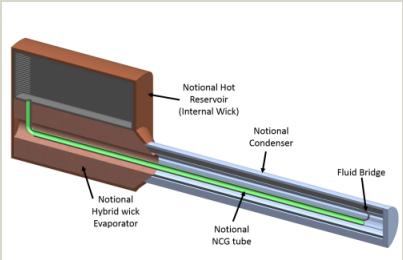
August 2019: Closed out

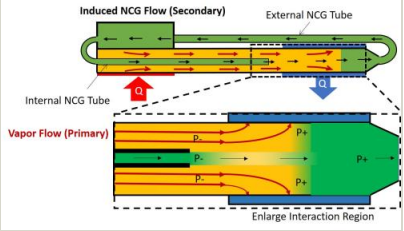
Closeout Documentation:

- Final Summary Chart*(https://techport.nasa.gov/file/141244)*

Images



Briefing Chart Image
Advanced Hot Reservoir Variable Conductance Heat Pipes for Planetary Landers, Phase I *(https://techport.nasa.gov/image/134696)*



Final Summary Chart Image
Advanced Hot Reservoir Variable Conductance Heat Pipes for Planetary Landers, Phase I *(https://techport.nasa.gov/image/132447)*

Technology Areas

Primary:

- TX09 Entry, Descent, and Landing
  - TX09.4 Vehicle Systems
    - TX09.4.5 Modeling and Simulation for EDL

Target Destinations

Earth, Others Inside the Solar System